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Contour-Furrow Irrigation

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Soil Conservation Service

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UNITED STATES DEPARTMENT OF AGRICULTURE

CONTOUR-FURROW IRRIGATION

By Karl O. Kohler, Jr., *formerly Chief, Regional Engineering Division, Pacific Region, Soil Conservation Service*

Contour-furrow irrigation can save irrigation water, reduce erosion, and mean better crops on sloping fields. You waste little water by surface runoff or by overirrigation at the upper end of the furrows. In comparison with down-slope irrigation, water in contour furrows moves more slowly across the field and, therefore, does not erode or wash the soil. You get a more even distribution of water over the field, making good growing conditions for all of the plants. This pays off in better yields and in higher quality products.

Irrigation water flowing down sloping fields is wasting our basic soil and water resources at a very serious rate. Contour-furrow irrigation can be a deciding factor in maintaining our agricultural production and our standard of living.

What Is Contour-Furrow Irrigation?

With contour-furrow irrigation, water is carried *across* a sloping field rather than down the slope. The furrows have just enough grade to carry the irrigation streams. Head ditches or pipelines are run downhill, or slightly across the slope, to feed the individual furrows. When you use contour furrows to irrigate, it is much the same as if you moved furrows from a steep field to a flat bottom-land field.

Terms Used In Contour-Furrow Irrigation

Through furrows are fed from the head ditch and run across the entire field, or to the next head or waste ditch (chart 1).

Spur furrows are fed from the head ditch, but end somewhere out in the middle of the field.

Fill furrows start in the middle of the field and do not extend to the head ditch or to the waste ditch. They are fed by cutting the water across from another furrow. This area is not always planted.

Spike furrows start in the middle of the field and extend on to the waste ditch. Like fill furrows, they are fed by cutting water across from another furrow.

Guidelines are run across the field on the irrigation grade as guides for planting.

Where Can Contour-Furrow Irrigation Be Used?

You can use the contour-furrow method of irrigation successfully on nearly all irrigable soils. Very light sandy soils and heavy adobe soils that crack badly when dry are exceptions. These soils should not be irrigated by this method.

Very sandy soils are unstable, and the ridges between furrows are apt to break or wash out. This may let the water from one furrow flow into the next lower furrow, overloading that furrow and causing it to break over into the next lower furrow. Breaks like these, if they occur, are apt to continue all the way down the slope, causing heavy erosion damage. Cracks that occur in heavy adobe soils make channels for similar down-slope furrow breaks and field erosion.

You can irrigate nearly all truck crops successfully by the contour-furrow method. Deep-furrowed row crops, such as potatoes, can be irrigated on slopes up to 8 percent on medium- and heavy-textured soils.

On light soils, plantings should usually be limited to slopes less than 5 percent because of the danger of furrow breaks. For efficient irrigation of shallow-furrowed row crops, your contour plantings should be

Tomatoes planted on the contour under hotcaps, ready for irrigation.

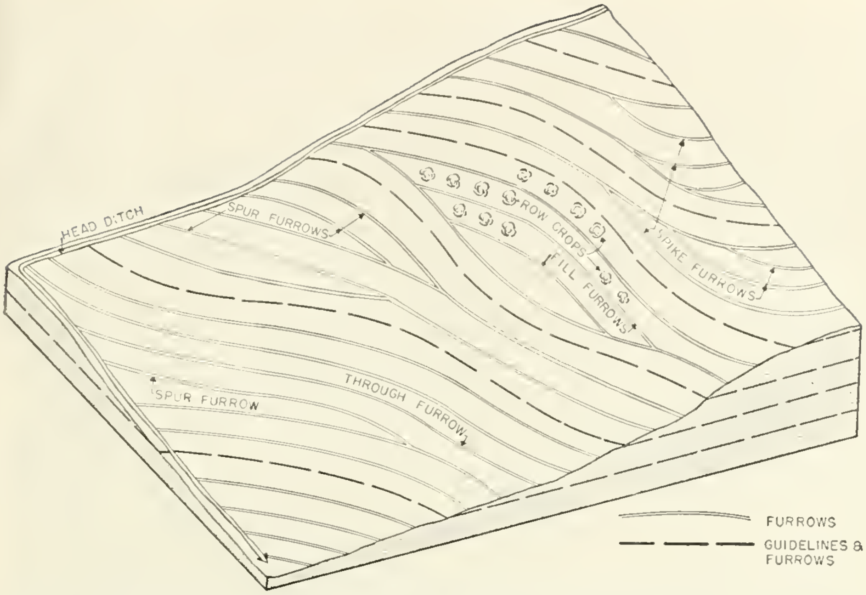


***Chart* 1.—Contour row-crop planting showing various types of furrows (See "Terms Used in Contour-Furrow Irrigation," p. 2).**

limited to lands having slopes of less than 3 percent.

Permanent plantings such as citrus and deciduous fruits, cane berries, vineyards, and nut trees can also be irrigated successfully with contour furrows. Where the furrows used in irrigating such crops need not be disturbed by cultivation, they can be used on land with slopes up to 20 percent. Under ideal conditions of soils and topography, land steeper than that has been successfully irrigated. The furrows also carry off excess rainwater safely during the rainy season and thereby help to prevent erosion on your fields.

A field with a uniform down slope and cross slope will have the highest number of through furrows and the smallest number of point rows (a crop row starting or ending part way across a field). It will also be the easiest field to irrigate. The more broken the topography, the more irregular will be the furrow and planting pattern.

The topography must be uniform enough to permit a head ditch that can feed the entire area of contour furrows. It also must be regular enough to permit installing a waste ditch to carry off surplus irrigation water and rainwater. Irregular topography increases your labor costs for irrigation. It also increases your planting, cultivation, and harvesting costs.

Fields should be smoothed as much as possible by land grading and floating before contour plantings are laid out. Shallow soils may limit the amount of smoothing that can be done.

Design and Layout of Contour-Furrow Plantings

Here are some of the things you need to know in planning a contour-furrow irrigation system:

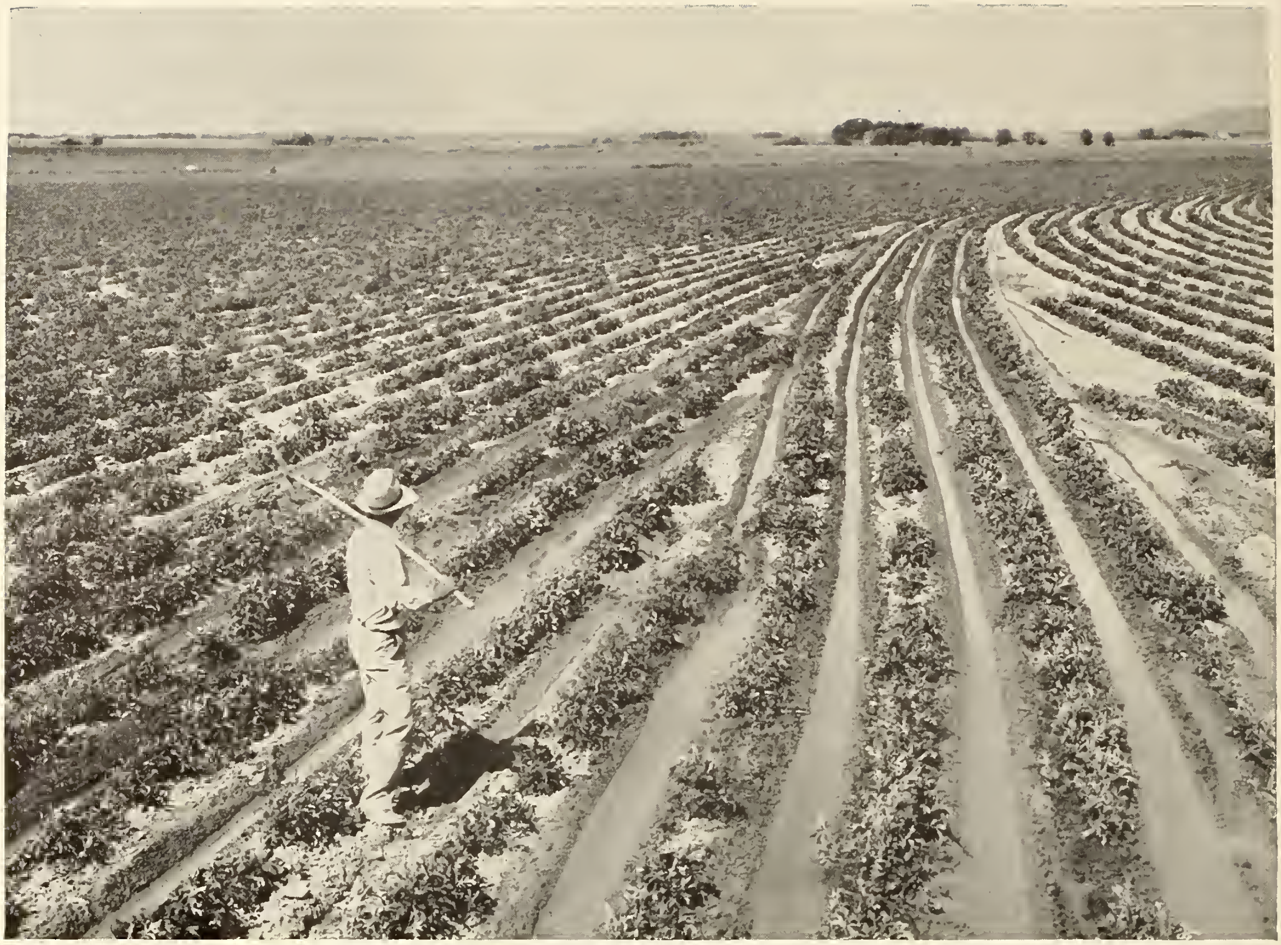
1. The soil depth and the root-zone depth of the crops you plan to raise. The soil must be deep enough to allow a satisfactory plant-root development and to permit some smoothing of the soil surface, if needed.

2. The rate that water enters the soil. This intake rate may be as low as 0.2 inch an hour or as rapid as 1.5 inches an hour or more. This rate is needed to determine the right length and spacing of irrigation furrows to be used in your field layout.

3. The capacity of your soil to hold water for plant use. The storage capacity may range from as little as 1 inch of water a foot of root-zone

Contour-furrow irrigation of lettuce on a 0.25-percent slope. The irrigation runs are 1,100 feet long.

Strawberries planted on sloping land in California are commonly irrigated on the contour.



Potatoes irrigated by contour-furrow irrigation. The furrows that run the entire length of the field are called through furrows. Those that end in the middle of the field are called spur furrows.

depth to more than 2.5 inches. The water-holding capacity of the soil determines both the amount of water that can be applied at each irrigation and the length of time between irrigations.

4. How much water you can run in a furrow without causing erosion.

If your farm is in a soil conservation district you can get technical assistance for your contour plantings through the district. Soil Conservation Service technicians working with your district will assist you in deciding what land is suitable for contour-irrigated plantings. Your soil conservation district will also help you plan and lay out your contour system.

Row-crop layout

Here are some things you will need to do in making a layout for contour-furrow irrigation of row crops:

1. Get a contour map of your field to determine the most efficient layout of the head ditches, waste ditches, and guidelines. This map will enable you to make an approximate layout of the water-distribution system and planting rows. It will also enable you to pick out areas you may need to "level."

2. Where "leveling" is advisable to smooth out the row alinement or increase the number of through rows, you should find out whether earth moving is feasible. If you do "level," change the topographic map to fit the new land surface.

3. Lay out the head ditches on the map to fit the topography. They should be on a grade that will not erode or on a controlled grade established by the use of flumes, surface pipe, or drop structures. They should be spaced to allow for proper lengths of run.

Try to locate head ditches so you will have as many through and spur furrows as possible and few fill and spike furrows. This will make your irrigation, cultivation, and harvesting easier. The lengths of furrow runs will vary with the slope and soils. They will also have to be reduced in length if more than 25 percent of the planted area is irrigated by spike or fill furrows.

Waste ditches should also be laid out. Locate them where they will interfere least with farming operations. They, also, must be on grades that will not erode. Underground pipelines can be used as waste ditches.

4. Lay out guidelines on the map on a nonerosive grade for irrigation

flows (chart 2). The fall should usually be about 0.5 foot in 100 feet. In areas that are apt to get heavy rains during the cropping season, you may need to increase the furrow grade slightly so that the furrows can carry off the surplus rainwaters without overtopping. Guidelines should generally be about 50 feet apart. On rough fields closer spacing may be better. If guidelines spread to more than 100 feet apart on any field, put in an extra line.

5. Stake planting guidelines on the ground. Start at the head ditch and set stakes every 50 feet. Extra stakes will be needed on ridges and in swales. The stakes must be set on the irrigation grade. Do not attempt to smooth out curves by moving stakes off the grade line. Since you can place permanent markers on the edge of the field where the guidelines start, the same guidelines can be staked the next time the field is planted on the contour.

6. Plant the field. Start your planting on the lowest guideline and work up the slope with parallel rows (chart 3). Cultivate and harvest the crops the same way. Start at the bottom and work up the slope.

7. Install your annual head and waste ditches. Where these ditches are on grades that will erode, install structures needed to prevent erosion.

Orchards and other permanent planting layouts

The contour map and land-grading needs are the same for this type of planting as for row crops irrigated by contour furrows. After you have decided on the final land-surface form, lay out the head and waste ditch or pipeline system. This kind of planting will be established for a number of years without change. For that reason, your ditch system will be more permanent than the system for your row crops.

Here are four simple rules for locating ditches and laying out a field:

1. Locate head ditches to give the proper length of furrow run. Constant lengths of run are desirable in an orchard block.

2. Locate head ditches on the minimum ground slope (usually a ridge), if possible. This way you will have spur rows irrigating from the head ditch in place of fill or spike rows that must be fed from other furrows.

3. Keep pipelines away from sharp depressions.

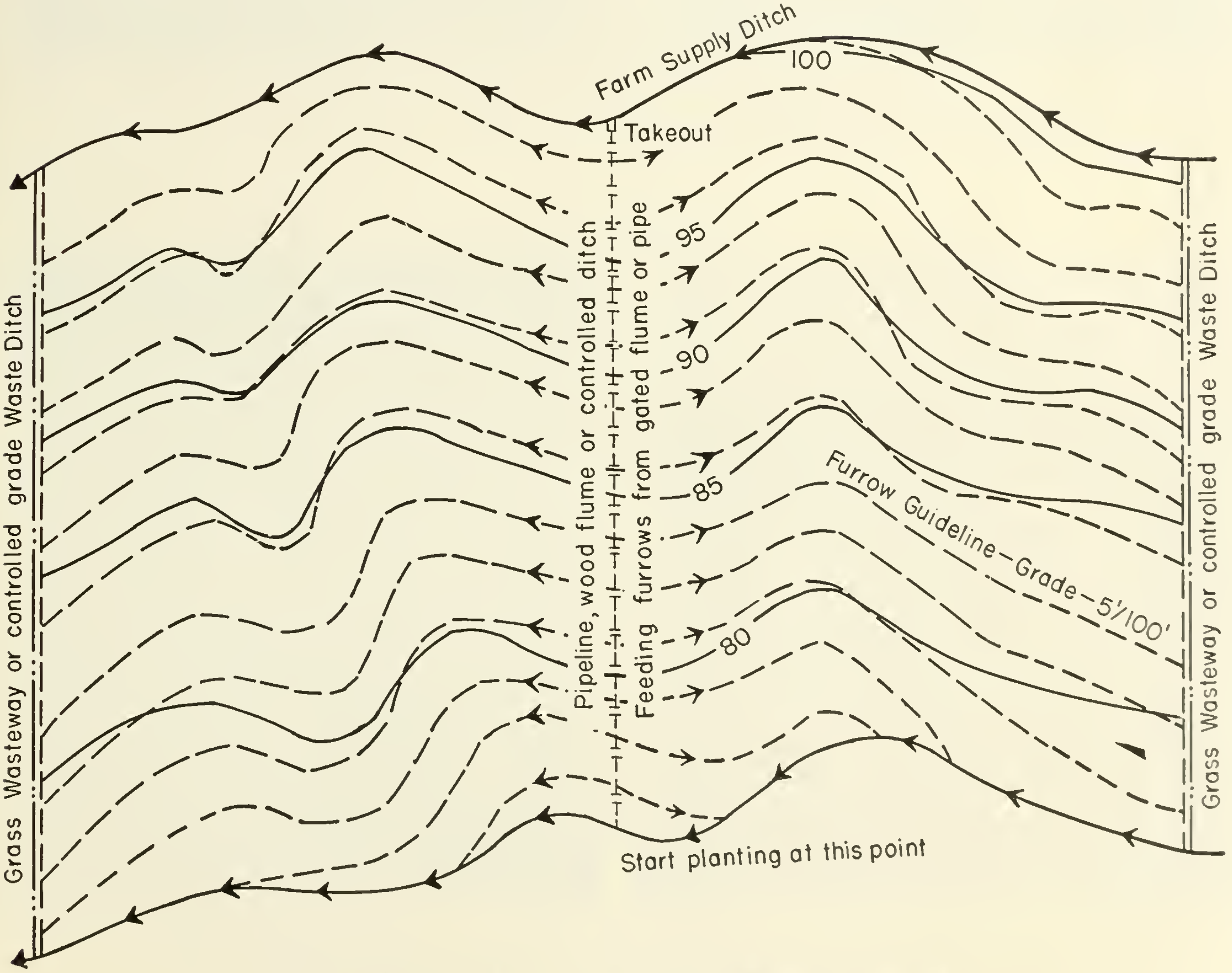
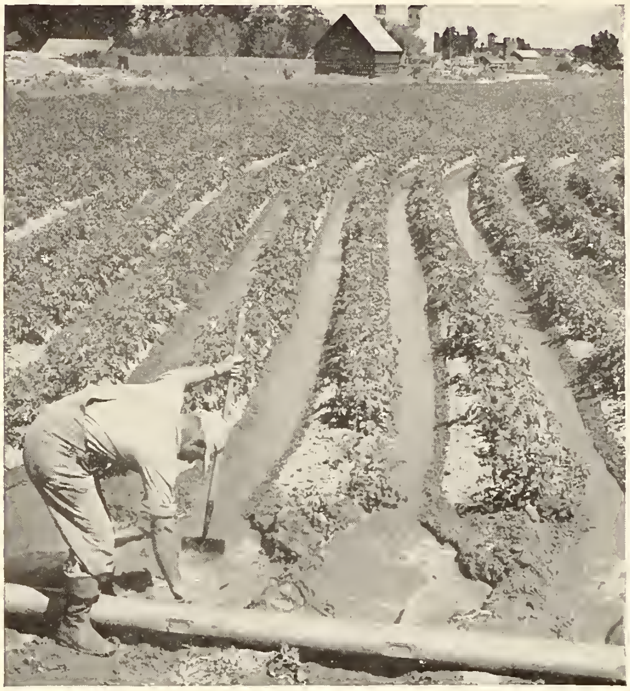
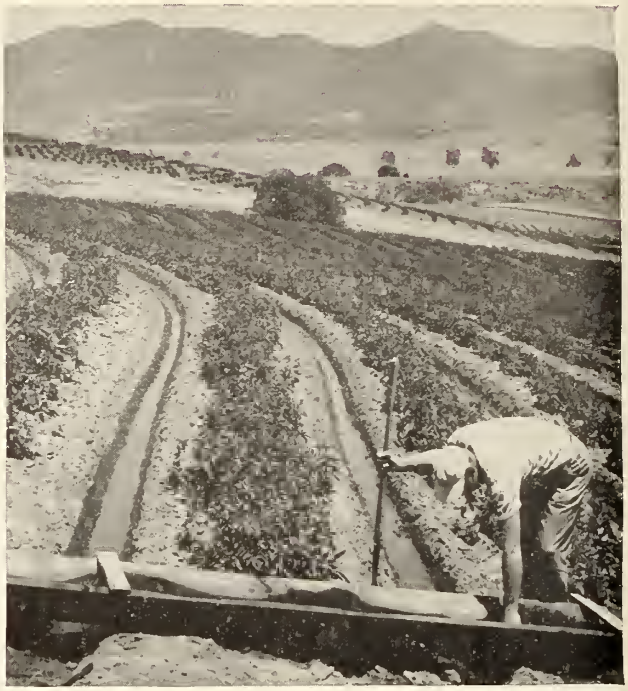

Farm Supply Ditch
100
Takeout
95
90
85
80
Pipeline, wood flume or controlled ditch
Feeding furrows from gated flume or pipe
Furrow Guideline—Grade—5/100'
Grass Wasteway or controlled grade Waste Ditch
Grass Wasteway or controlled grade Waste Ditch
Start planting at this point

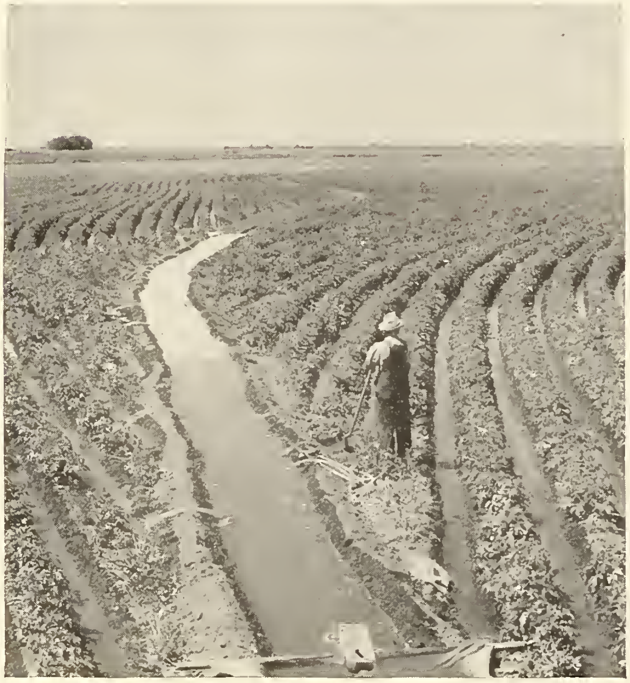
Chart 2.—Guideline layout for contour-furrow row-crop planting.



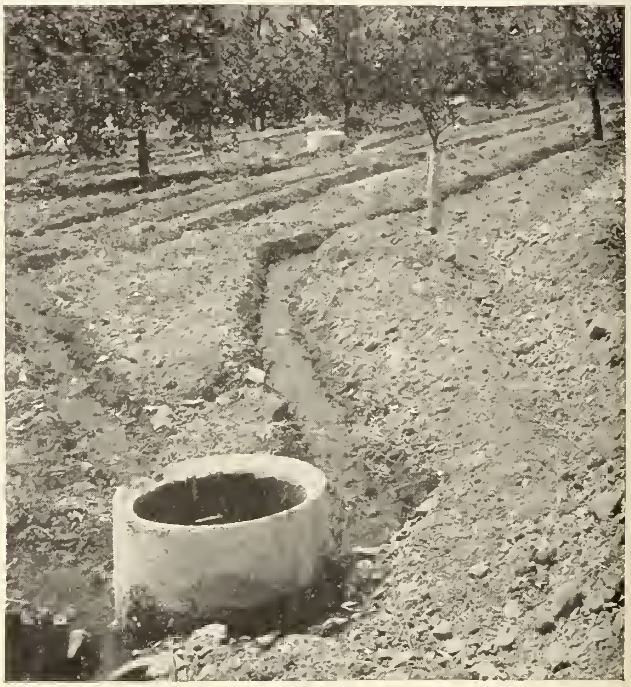
A gated surface pipe distributes water to this contour-furrow irrigated potato field.



Early tomatoes planted and irrigated on the contour. Water is carried to furrows in wooden V flumes.



A contour-irrigated potato field. Runs are shortened by head ditches that intersect the field. Plastic siphons lift the water from the head ditch into the furrows.



A contour-planted citrus orchard irrigated by long furrows. Concrete pots are used to distribute water in the furrows from underground pipelines.

4. The shortest head ditch that will satisfy the above conditions will be the cheapest. It never pays, however, to save a little pipeline at the cost of making farm operations more difficult.

As a practical minimum, furrow grades for your permanent plantings should be about 0.5 foot for each 100 feet. As a maximum, they should not be great enough to develop an erosion problem from either irrigation water flows or from rainwater.

Usually you will have to increase the grades of furrows on steep lands. Most furrows on steep land do not have much bank on their downslope side. Therefore, the large furrow streams you would use for the flatter irrigation grades are apt to break over and cause erosion. If you use smaller irrigating streams, you can increase the grades up to 2 feet for each 100 feet where cover crops are used.

It is often advisable to shorten the furrow lengths on the steeper slopes. On slopes under 6 percent, trees in contour-furrow rows (chart 4) can be alined up and down the slope to permit cross cultivation for better weed control. This may, however, result in fewer trees per row.

On steeper slopes, since up-and-down-hill cultivation may start erosion, it should not be attempted. Therefore there is no advantage in alining the rows on these steeper slopes.

Maintenance of Contour Furrows

Contour furrows for row crops are installed annually. You will use them only in those years of a rotation when the field is in row crops. Many operators, however, leave them in through the rainy season following the row crops to catch and carry off excess rainfall. If you do this, keep the waste-ditch system open to dispose of the runoff.

Since your orchard or other permanent contour plantings will use the same furrows and waste ditches every year, you can consider them a permanent part of your water-disposal system. Furrows and waste ditches should be cleaned out and prepared for the rainy season immediately after crops are harvested.

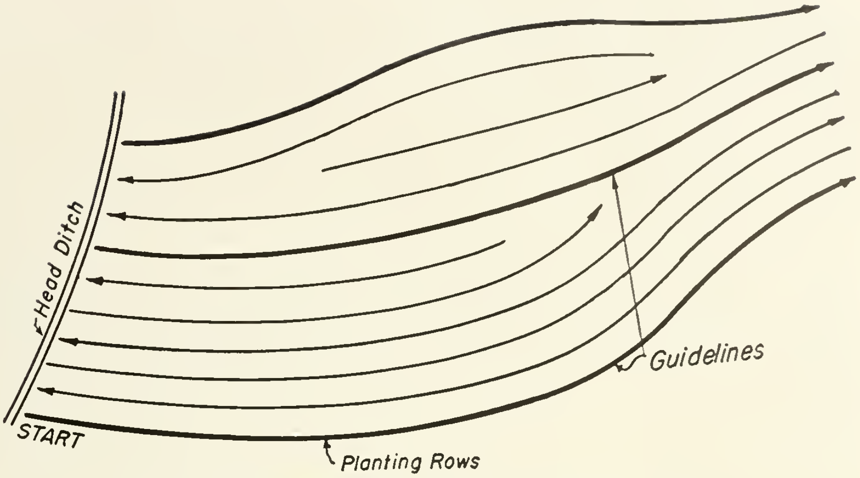


Chart 3.—Planting procedure for contour row crops.

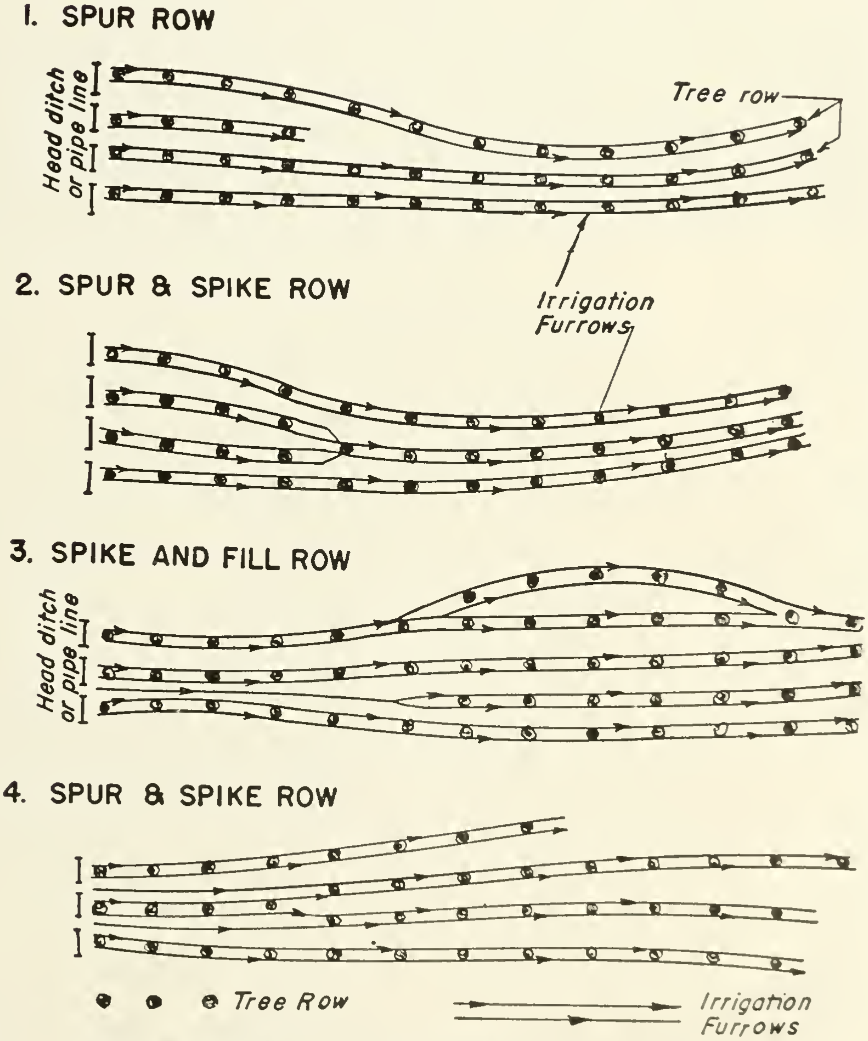
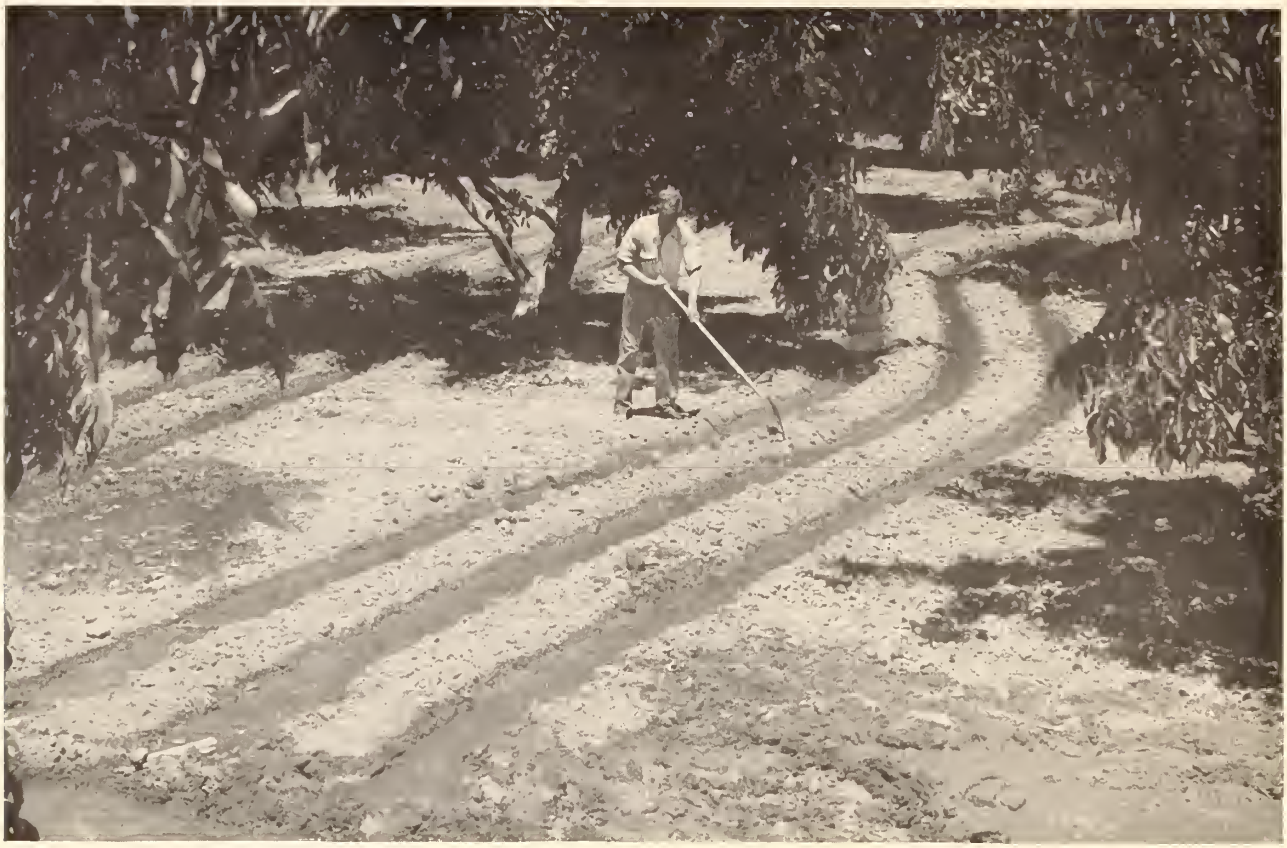


Chart 4.—Orchard contour planting on uneven topography.



Contour-furrow layout of a walnut grove.

Advantages of Contour-Furrow Irrigation

This method of irrigation—

1. Reduces the erosion hazard in each furrow and permits you to irrigate efficiently land too steep for downhill furrows.

2. Provides more uniform distribution of irrigation water. With nearly level furrows running across the slope the water is better distributed between the furrows.

3. Saves water. When the entire length of furrow is supplied with water soon after irrigation begins, less water is wasted below the root zone at the head of the runs. Also, with flatter irrigation grades, you have better control of the water and can reduce waste runoff at the lower end of the furrows. Under some conditions the water-saving features of contour-furrow irrigation may permit the irrigation of as much as 40 percent more land.

4. Reduces the time needed for irrigation. The deeper, slow-moving flows of water in the contour furrows soak into the soil quicker than the small, fast-moving streams used in down-slope irrigation. The water needed by your crops can, therefore, be applied more quickly.

5. Reduces irrigation labor costs. It generally takes more labor for the first irrigation using contour furrows. But after furrow streams have once been adjusted to take care of fill and spike furrows, less labor is required. Generally, the seasonal labor costs of contour-furrow irrigation are much less than those of down-slope irrigation.

6. Reduces power costs. Your equipment will be operated across the slope most of the time. This requires less power than operating up and down the slope.

7. Produces more uniform crop stands, increases yields, and improves quality.

Disadvantages of Contour-Furrow Irrigation

This method has disadvantages—

1. Requires protected head ditches and waste-water ditches. Since the furrows run across the slope, these ditches generally run directly down slope. To prevent erosion, you may need pipes or flumes for head ditches and drops, underground pipelines, or other structures to protect waste-water ditches.

2. Requires equipment turns on the field. Equipment used in planting, cultivating, and harvesting has to be turned on the field at the end of the spur, spike, and fill furrows.

3. Requires engineering layout. Fields must be carefully planned and then planted between staked guidelines, running across the field on the proper irrigation grade.

4. Requires control of water in furrows. A break may damage lower furrows and cause erosion.

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